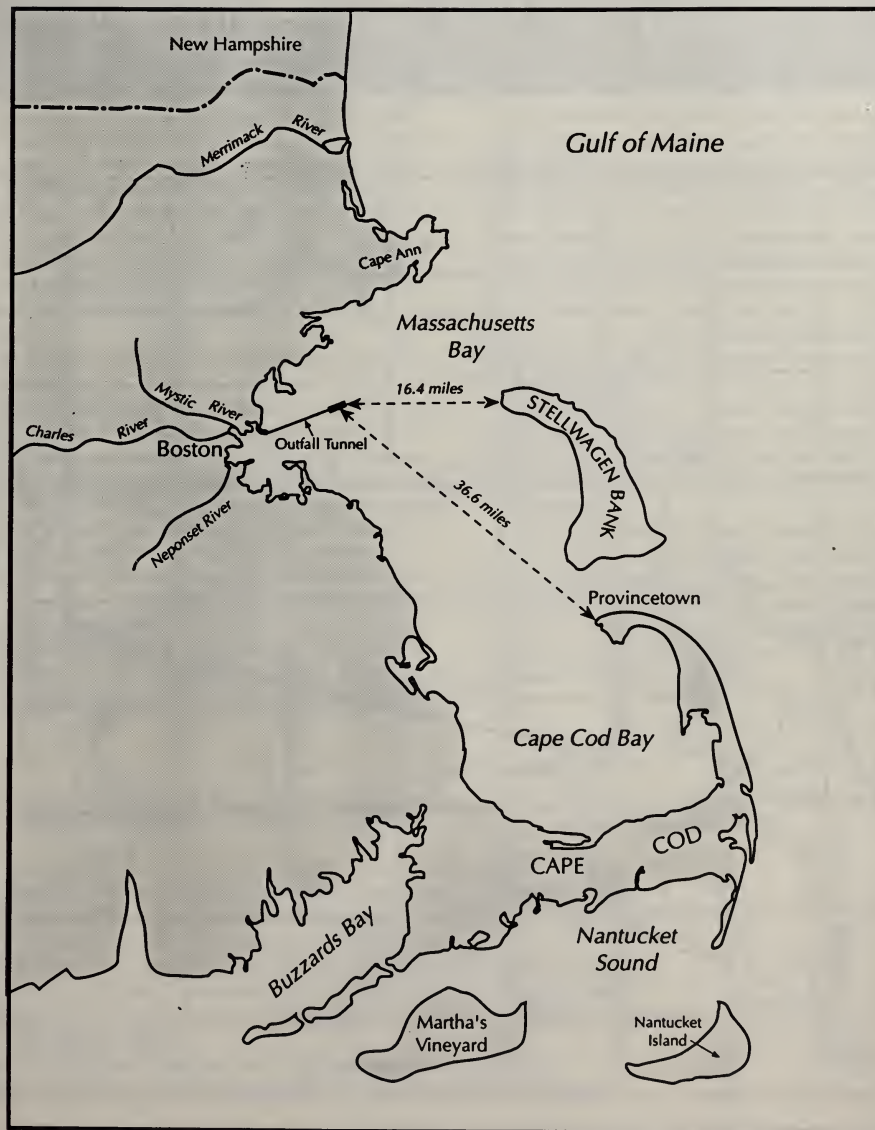
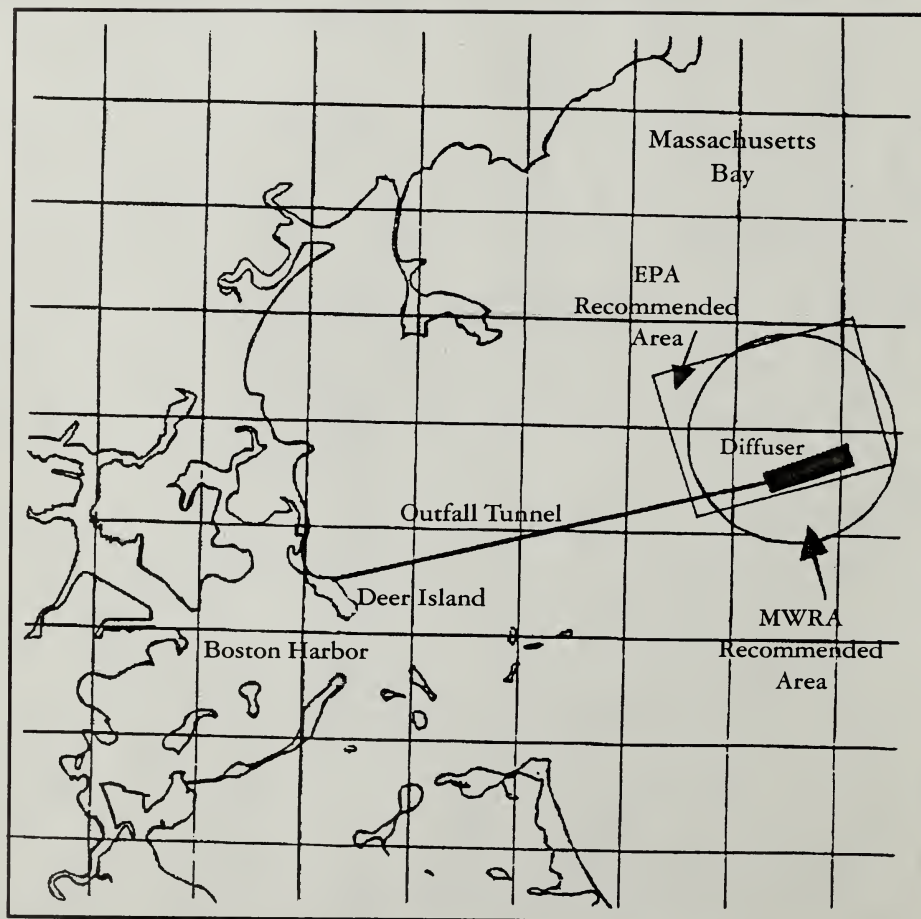


Massachusetts Bay



Effluent Outfall Site Selection



but for Massachusetts and Cape Cod Bays. No adverse environmental impact to Stellwagen Bank is expected from construction and operation of the MWRA's pollution control facilities.

Monitoring

To verify the predictions that operation of the new outfall and treatment plant will result in significant improvement to the environmental quality of Boston Harbor without adverse effect on Massachusetts and Cape Cod Bays, the MWRA is required by EPA and the Massachusetts Executive Office of Environmental Affairs to monitor the effects of its discharges. In addition, the Authority must demonstrate to the residents of its sewerage district, who will bear the cost of the construction, that the multi-billion dollar project results in protection of the marine environment.

The MWRA has initiated a monitoring program that will focus on areas likely to be affected by discharge through the outfall. To identify these areas, MWRA is supporting studies by the U.S. Geological Survey in Woods Hole. USGS is measuring the motion of water and bottom sediments in the outfall area over several years. In addition, USGS is measuring the present levels of contamination in sediment samples from several locations in Massachusetts Bay.

Other ongoing biological studies are determining the baseline condition of phytoplankton (tiny plants that form the base of marine food chains), and the water properties that can stimulate or impair their growth. These studies have indicated that most of the existing sewage discharges move quickly from Boston Harbor to Massachusetts Bay.

Based on this work, the outfall siting studies and the USGS research, the MWRA is designing a long-term monitoring program that will measure pollutant concentrations and ecosystem status before and after the outfall begins to operate. Samples of water, sediments and marine plants and animals will be collected from the outfall area, from Stellwagen Basin (the deep area inshore of Stellwagen Bank) and possibly from Cape Cod Bay.

The monitoring program is reviewed and approved by a subcommittee of the Massachusetts Bays program, a joint state/federal program to study Massachusetts and Cape Cod Bays. The subcommittee is composed of area scientists, regulators and environmentalists. In addition, the Massachusetts Bays program is sponsoring several research programs in the Bays and in Boston Harbor. For example, a group of oceanographers is studying the circulation of Massachusetts and Cape Cod Bays, including the flow over and through the passages north and south of Stellwagen Bank, and the exchange between the Bays and the Gulf of Maine.

These studies will increase our understanding of the Massachusetts Bays environment, and give us additional confidence that the monitoring programs are accurately measuring the impacts and benefits of MWRA pollution control activities.

MWRA effluent discharges are regulated by a permit issued by the EPA and the Massachusetts Department of Environmental Protection. By law these permit limits must protect the water quality of Massachusetts and Cape Cod Bays. If monitoring data show that the water quality is being impaired, then the EPA and DEP will tighten the discharge permit limits.

Boston Harbor Project Milestones

September 1990 -- Construction begins on outfall tunnel.

December 1990 -- Construction begins on primary treatment plant.

December 1991 -- Sludge processing plant completed. Sludge is removed from wastewater and processed on land.

January 1993 -- Construction begins on secondary treatment plant.

July 1995 -- Primary treatment plant and outfall tunnel completed.

October 1996 -- One-quarter of the secondary treatment plant completed. Operations begin.

June 1998 -- Half of secondary treatment plant completed.

December 1999 -- Entire secondary treatment plant completed.

ing of 50 tons of sludge into Boston Harbor. Instead, the sludge will be converted to a pellet fertilizer that can be used on land.

The MWRA's new primary treatment plant and outfall tunnel will be completed in July 1995. The new primary plant will remove 60 percent of solids, up to 40 percent of toxins and reduce biochemical oxygen demand (BOD) by 35 percent.

The new secondary treatment plant will further treat the effluent from the primary plant. Combined primary and secondary treatment removes 85 percent of solids, 50 to 85 percent of toxins and reduces biochemical oxygen demand by 85 percent.

Construction on the secondary plant will begin in January 1993. One-quarter of the plant will be completed by October 1996, enough to treat much of the dry weather flow. Half of the secondary plant will be completed in 1998 and the entire plant in 1999.

Impact on Stellwagen Bank

Although the new outfall is closer to the Bank than the present ones, the MWRA believes that it is extremely unlikely that discharge through the planned outfall will have an adverse effect on the environmental quality of Stellwagen Bank. In fact, except for a small area around

the end of the new outfall, water quality should improve throughout Massachusetts Bay.

Improvement will occur because of the increased dilution provided by the diffuser and because the wastewater will receive a level of treatment 10 times more effective than current treatment. There is no evidence that the present discharge of sewage to Boston Harbor is now affecting the environmental quality of the Bank, but if it is, then the MWRA pollution control projects will mitigate that impact.

Because the outfall is far from all known fish spawning and nursery areas and because of the very low concentrations of sewage-derived pollutants expected to reach Stellwagen Bank, no effect on fishery resources or on aesthetics is anticipated. Since the new outfall is far from any Cape Cod shoreline, there will be no impact on Cape beaches even under worst-case conditions.

In its *Environmental Impact Statement*, the EPA notes that it is unlikely that whales or sea turtles, which come to Stellwagen Bank to feed on the small fish and zooplankton (tiny marine animals) found in abundance near the Bank, will be directly affected by the discharge of effluent.

The new outfall and treatment plant will result in improved environmental quality, not only for Boston Harbor,

Circulation in Massachusetts Bay

Massachusetts Bay and Cape Cod Bay are located on the southwestern end of the Gulf of Maine, part of the Gulf of Maine/Bay of Fundy system. The Gulf of Maine has some of the largest tides in the world, as much as 50 feet high. Tidal currents dominate the water circulation in the bays and are important in mixing, as well as determining the long-term, far-field movement of pollutants.

In addition to tides, the currents in Massachusetts Bay are driven by the weather and by seawater density differences. Except during the spring, when freshwater inflow from the Merrimack River causes a density-driven current pattern, there is no clearly defined

pattern to the circulation. The lack of pattern, which means that the currents at the outfall site go in all directions, will help to disperse the effluent from the MWRA's outfall tunnel.

The MWRA's oceanographic studies show that western Massachusetts Bay can be divided into three flow-type regions: deep channels entering Boston Harbor; near-coastal waters; and the offshore region.

The shipping channels, where present outfalls lie, have very swift tidal currents and effective mixing. The channels are, however, too shallow for effective dilution of pollutants and they are also too close to beaches.

The nearshore regions studied, Broad Sound and Nantasket Bight,

are relatively shallow and sheltered.

In the offshore region, the tidal currents are less important than in the other two areas, while the non-tidal circulation is greater and more energetic.

There is a gradual transition between the nearshore and offshore regions. The change is evident from the biological and chemical measurements as well as the ocean current data; different animals live in each region and there are more contaminants in nearshore sediments. The site for the new outfall was chosen to lie in the offshore area, where the effluent would receive greater dilution.

At present, discharges from the MWRA's existing plants are initially diluted by about 10 parts of seawater to one part of effluent (10:1). After discharge through the new outfall diffuser, the effluent will be initially diluted by as much as 200 parts of seawater to one part of effluent (200:1). With this 20-fold increase in dilution and a 10-fold improvement in treatment, the effluent will meet water quality standards within the mixing zone. After initial mixing, the effluent is mixed and dispersed further by waves and currents.

After initial dilution, the movement of the effluent depends on the currents. In Massachusetts Bay, the currents vary from place to place and with the seasons and generally have no clearly defined circulation pattern. The fact that the currents at the outfall site go in all directions greatly assists in dispersing the effluent.

Compared with present conditions, the effluent will receive greater dilution at its new discharge location, as well as a greatly improved level of treatment.

Site selection studies

The special nature of Stellwagen Bank was one of the factors considered by MWRA and U.S. Environmental Protection Agency scientists charged with researching a new site for the effluent outfall tunnel.

In order to determine a site for the outfall that would provide adequate protection for the resources of the Bay, the MWRA conducted a study of the coastal ocean environment and the effects of the proposed discharge on surrounding waters using extensive scientific data and information about the Bay's marine resources.

The MWRA studies were prepared by a number of companies and institutions, including the environmental engineering firm of Camp, Dresser and McKee, Battelle Ocean Sciences, the U.S. Geological Survey in Woods Hole, the Massachusetts Institute of Technology, Science Applications International Corp., the University of New Hampshire, the University of Rhode Island and the New England Aquarium.

Over a 15 month period in 1987 and 1988, about \$10 million was spent on physical, biological, chemical and geological oceanographic studies as part of the MWRA's *Secondary Treatment Facilities Plan*.

These studies refined the current understanding of Massachusetts Bay circulation: they indicated that the outfall should be placed 6.5 to 10 miles into Massachusetts Bay in an area that has deeper water and more vigorous circulation than the nearshore region. The studies concluded that if the outfall were located too close to shore

(less than six and one-half miles), tides could cause inadequately diluted wastewater to reach shoreline areas, possibly affecting beaches and shellfish beds.

Along with oceanographic measurements, a computer model of pollutant transport in Massachusetts and Cape Cod Bays was used to predict the likely effects of discharge through the new outfall. For each of several candidate outfall sites, the model was used to predict whether pollutant concentrations would exceed federal or state water quality standards. Several other criteria were used by MWRA and by the EPA in evaluating the various outfall options. The criteria, which were based on discussions with citizen and scientific advisory groups, included protection of commercial on-the-water activities, maintenance and enhancement of aesthetics and avoidance of areas of important habitat.

The EPA conducted an independent analysis of MWRA data to select an appropriate outfall site as part of an *Environmental Impact Statement* required by the National Environmental Policy Act. In a *Public Record of Decision* issued in November 1988, the EPA identified an area from six and one-half to 10 miles east-northeast of Deer Island as the recommended site for the terminus of the outfall tunnel. The MWRA study had independently identified an overlapping area. Determination of the exact location of the diffuser within these overlapping areas was based on engineering considerations.

Treatment plants

Although the new outfall is an important part of the MWRA's pollution control strategy, it is not the only part. The MWRA has begun construction of a new treatment plant on Deer Island to replace its aging, unreliable plants on Deer and Nut Islands. Construction has also begun on a 5-mile long tunnel to convey South Shore wastewater from a new headworks, to be constructed on Nut Island, to the Deer Island treatment plant.

Currently, wastewater treated at the MWRA's existing treatment plants on Deer Island and Nut Island in Boston Harbor receives inadequate primary treatment before being discharged less than a mile from shore in shallow water. Sludge (mostly fecal matter and other organic solids) removed from the effluent undergoes additional treatment called digestion before being dumped along with the effluent on the outgoing tide. Because it is discharged on the ebb tide, much of the sludge ends up in Massachusetts Bay.

Beginning in December, the MWRA will process sludge at a plant in Quincy, thus ending the daily dump-



Boston Harbor Project Massachusetts Bay

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As part of the Boston Harbor Project, the Massachusetts Water Resources Authority is building a nine and one-half mile long effluent outfall tunnel that will extend from Deer Island in Boston Harbor to Massachusetts Bay. The tunnel, now under construction, will convey treated wastewater (effluent) from a new primary and secondary wastewater treatment plant to the deep waters of the Bay, where it will be dispersed through 55 riser pipes (called a diffuser) over a distance of one and one-quarter miles. There will be no sludge (solids) in the effluent that will be released through the outfall tunnel.

The MWRA selected an outfall site nine and one-half miles into Massachusetts Bay after concurrent studies by the MWRA and federal Environmental Protection Agency identified proposed locations for the outfall. Both the EPA and MWRA concluded that the ideal site for the terminus of the outfall tunnel would be an area roughly six and one-half miles to 10 miles east-northeast of Deer Island. The final outfall site, nine and one-half miles east-northeast of Deer Island, was approved by the EPA and the Massachusetts Executive Office of Environmental Affairs.

The outfall tunnel

The MWRA's new effluent outfall tunnel, which is being excavated through solid rock about 350 feet below the sea floor, will be nine and one-half miles long and 24 feet in diameter when completed in 1995. The last one and one-quarter miles of the tunnel will be connected to 55 vertical riser pipes. The risers will bring the effluent up 240 feet to the sea bottom where it will be thoroughly dispersed by ocean currents. The water depth at that location is 110 feet.

The outfall tunnel will end approximately 16 and one-half miles from the western tip of Stellwagen Bank, and 36 and one-half miles from Race Point in Provincetown. Discharges from MWRA treatment plants presently take place 25 miles from the tip of Stellwagen Bank.

Stellwagen Bank

Stellwagen Bank has served New England as a prized fishing ground, shipping route and recreational area since the first settlers arrived over 300 years ago.

Stellwagen Bank is a sandy underwater plateau, 20 nautical miles long and about seven miles wide, at the eastern edge of Massachusetts Bay. The nutrient-rich waters of the Bank are a feeding ground for several species of whales, including the endangered humpback, North Atlantic right, fin and sei. Dolphins and porpoises also feed on the plankton present in the light-filled waters. Water over the Bank is relatively shallow, ranging from 60 to over 120 feet deep, while surrounding waters are more

than 300 feet deep. Currents in the area mix nutrients from the bottom of the ocean to the surface. Large quantities of tiny plants and animals, including algae, small crustaceans and fish larvae, grow on and over the Bank, making it one of the most productive marine environments in the United States.

The area is known for its diversity of fish species. More than 140 types of fish have been identified on Stellwagen Bank. Numerous species of sea birds and sea turtles are present in the area at certain times of the year. Stellwagen Bank is also a center for whale watching, which has become a valuable part of the region's economic base.

Stellwagen Bank has been nominated for designation as a National Marine Sanctuary. Such status would protect the Bank's resources.

Dilution of effluent

The MWRA designed the outfall tunnel and diffuser system to provide maximum dilution (mixing) of the treated effluent with seawater.

The initial dilution is affected by the rate of flow of effluent, the water depth, the height to which the lighter plume of effluent can rise before it is the same density as seawater and local currents that bring in water from outside the mixing zone.

Generally, deeper water provides greater dilution, since the higher the plume rises, the more seawater there is available to mix with the effluent. The height to which the plume rises is determined by stratification (the vertical variation in seawater density).